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SOME PINEAPPLE PROBLEMS.

18th ARTICLE. - THE PLANT NUTRIENTS. (CONTINUED.)

By Henry C. Henricksen.

PHOSPHORUS. - As this element is needed, in considerable quantities, by most plants, it is one of the three usually supplied in fertilizers. Phosphorus, being an acid-forming element, is supplied in the form of phosphoric acid. But as it is not convenient to handle it as such and as it will combine with bases in the soil anyway, it is always applied as a fertilizer in combination with some base, calcium, ammonium or potassium. All three have been used in the course of this investigation, extending over a period of more than six years. The results show, very conclusively, that the pineapple plant needs very little phosphorus for tissue building. In field experiments the plants fertilized with ammonium sulphate and potassium sulphate have invariably been larger, more vigorous and of better color than those receiving an additional application of phosphate salts. This indicates that the soil contained enough for the plant's need and that the extra amount supplied in the fertilizer created a condition unfavorable to its growth. Pot experiments conducted in 1924-25 gave results confirming those of the field tests. River gravel was used as a medium, but as it was not practicable to eliminate all phosphate from that, silica sand from the Ottawa Silica Company in Illinois was used in the 1925-26 tests, which were arranged as follows: Twelve-quart galvanized pails were punctured in the bottom, and a tube 2 inches long and 3/4 inch diameter was soldered into the puncture flush with the inside of the bottom. A small flower pot was inserted over the hole to supply drainage and to prevent the sand from going through. The pails were placed on a rack with a shelf underneath carrying two-quart glass jars, one under each pail, to receive the drainage. The legs of the benches were placed in pails of water to prevent ants from entering. But as no greenhouse was available the plants were subject to the dust from the adjacent street and also to the rains which were often so heavy as to necessitate changing the watering solutions twice a week.

The plants were watered with rain water, and to each series nutrient solutions were added in quantities, known from former experiments to be appropriate for normal growth. Series 1 received a complete solution including phosphate. Series 2 received a solution without phosphate. Series 3 received one-fifth the amount of series 1. Fourteen months after, when most of the plants were blooming, the leaves were counted and measured. But the results obtained showed practically no difference in leaf area. Also the color and general appearance of the leaves were practically the same in the three series.

A chemical analysis showed the following amounts of P_2O_5 in the leaves calculated as per cent of dry matter: Series 1, 2.65; series 2, 1.73, series 3, 1.90. The figures are consistent when comparing one series with another, but there is nothing to explain where series No.2 derived its phosphorus. It is true that some was present in the slip, some in the dust from the street and a little in the water, but that does not account for it all. Perhaps a mistake was made once in making up the solutions. At any rate, the experiment did not answer conclusively the question of absolute minimum phosphate required. That, however, is of minor importance to the pineapple growers. The fact remains that very little of it is sufficient for normal growth. The questions are: to what extent does that apply to fruit production and what is the ill effect of phosphate on foliage formation. The answer to the first question is that very little is needed. That is indefinite, but the results of the experiments conducted tell no more. The plats receiving no phosphate in the fertilizer or very small amounts produced more vigorous plants and eventually as large and as many fruit as those receiving fertilizers containing 6 to 8% P_2O_5. But the no-phosphate plats were much retarded in fruiting.

The effect of phosphate on the leaf tissue is that of maturing. That is, the leaves of plants in the phosphate plats function less vigorously and they cease to function much earlier than those of the no-phosphate plats. That is provable by the nitrate test on the leaves when plants are six to twelve months old. Eventually it is visible in the appearance of the leaf, that of the phosphate plat being dry and wilted much sooner than that of the no-phosphate plat. This information is not given as an absolute guide for pineapple fertilizing. There may be conditions different to those of the experimental fields, but the results indicate most strongly that more phosphate is being used in pineapple fertilizers in Porto Rico than is necessary. Also, it is unquestionable that the plants would make better growth, in some fields, with less phosphate than is now being used. Therefore, it is recommended that each planter should select plats and apply fertilizers containing one-half and one-quarter of the amounts regularly used. The results will show whether or not he would be justified in changing his fertilizer formula for the entire plantation.

I R O N. - As this can be determined rapidly and accurately, a great many determinations were made on leaves from plants that appeared to be different, one from another. The results show that apparently normal leaves contain 0.1 to 0.15% Fe_2O_3; calculated on the dry matter. Leaves that were chlorotic because of an overabundance of calcium carbonate in the soil usually contained less than the normal plants; but leaves that were chlorotic because of defloculated colloidal matter were seldom found to be deficient in iron. The question of iron in relation to phosphorus was closely investigated, but the results are inconclusive.

The plants in one plat receiving no-phosphate produced leaves that were constantly deficient in iron although they were green, healthy and exceptionally vigorous. Those from another no-phosphate plat contained the normal amount of iron throughout the growing period. Likewise, leaves from plants that received double applications of phosphate contained normal amounts of iron. The results from pot experiments were not very different from those of the field plats and it is concluded, therefore, that iron is not a determining factor except on calcareous soils as described by Gile, Bulletin No. 11, this Station.

S U L P H U R. - As the various fertilizer elements in combination with sulphuric acid are uniformly suitable for the pineapple plant and as sulphur is one of the most suitable products for rectifying certain soil defects, the question of sulphur in the plants' economy is of considerable importance. Sulphur determinations on leaf tissue show that plants fertilized with sulphates or with sulphur contain more of it than those grown without sulphur. The following is an example:

Fertilizers applied.	SO_4% of dry matter.
Ammonium sulphate Potassium sulphate	3.75
Potassium nitrate Acid phosphate	0.75
Potassium nitrate Acid phosphate S u l p h u r	3.25

The figures suggest that perhaps the beneficial effect of sulphur may be partly due to the plants' need of it for tissue formation. That has not been proved in this investigation for it is difficult to segregate the various effects. But from the results obtained the conclusions may reasonably be drawn that when ammonium sulphate and potassium sulphate are used for fertilizing the sulphur needs of the plant are amply supplied. On the other hand, the general appearance of the plant on soil heavily fertilized with sulphur indicates that it does not absorb so much of it as to impede its growth.